THE THELEPHORACEAE OF NORTH AMERICA. IV[1]

Exobasidium

EDWARD ANGUS BURT

Mycologist and Librarian to the Missouri Botanical Garden
Associate Professor in the Henry Shaw School of Botany of Washington University

EXOBASIDIUM

Exobasidium Woronin, Naturforsch. Ges. Freiburg Verhandl. **4**: 397–416. *pl. 1–3.* 1867.—Saccardo, Syll. Fung. **6**: 664. 1888.—Hennings, in Engl. & Prantl, Nat. Pflanzenfam. (**I.**1**): 103. 1897.

The type species of the genus is *Exobasidium Vaccinii* Fuck. ex Wor.

Fungi parasitic in leaves, shoots, and flowers, which they deform more or less, producing on the surface of these organs an effused hymenium, rarely composed of basidia alone and more usually felt-like and composed chiefly of interwoven hyphae bearing basidia and conidiophores; basidia simple; spores white, simple or septate.

Exobasidium resembles so closely in the thinness of its fructifications such species of *Corticium* and *Peniophora* as *Corticium byssinum, Peniophora asperipilata, P. pilosa,* and *P. subalutacea* that I follow Saccardo and include it with the above genera in the *Thelephoraceae.* Hennings in Engler & Prantl's 'Die Natürlichen Pflanzenfamilien,' has raised *Exobasidium* to ordinal rank but this is not justified by the structure of the many fructifications of *Exobasidium* which I have sectioned; the illustrations in text-books of the structure in section of the fructification are decidedly diagrammatic and simplified.

In his work already cited, Woronin gives a detailed account of the morphology and life history of *Exobasidium Vaccinii* and illustrates this account with three double plates. The interest in this fungus which Woronin's work aroused has

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NOTE.—Explanation in regard to the citation of specimens studied is given in Part I, Ann. Mo. Bot. Gard. **1**: 202, footnote.

resulted in the publication of other species by various authors, whose descriptions contrast sharply with that of Woronin in giving little weight to the morphological characters of the fungus under consideration, but extended description of the form and color of the gall of a particular collection, with passing reference to the occurrence of the fungus upon a hitherto unpublished host. In case of the galls, the descriptions usually fail to state what other forms besides the one mentioned the galls may have on other organs of the new host and likewise omit mention of the different forms they may have at other times in the year than the particular time at which the type collection was made. Woronin's description of *E. Vaccinii* was based upon field observations extended through two seasons, during which more than a thousand specimens were collected. He gives one double page colored plate to show the various types of galls produced by the different organs of *Vaccinium vitis-idaea.*

Plate 21 is a photographic reproduction, reduced one-fifth, of Woronin's colored plate; it shows the forms of galls as determined by the particular organ of the host, *Vaccinium vitis-idaea,* which makes hypertrophic response to local stimulation by the parasitic fungus. A local change of color from green to some shade of red is common in plant portions infested with *Exobasidium.* In the photographic reproduction of Woronin's plate the reddened areas of the original appear light colored. In fig. 1, the left side of the uppermost leaf was attacked by the fungus, producing what I term a leaf spot gall. The affected region of the leaf is reddened on the upper side and bears the fructification which may be felty or scurfy on the under side; this leaf is not distorted much in form and thickness.

Figures 2–9 present leaf galls, reddened on the upper side of the leaf and distorted and thickened by hypertrophic growth so as to become more or less concave with respect to the upper surface. I designate this form of gall as leaf concavity.

Figures 10–17 illustrate shoot galls, in the production of which, stems of the current season's growth have been greatly enlarged and have turned pale and slightly pink under the stimulus of the infecting fungus. In figs. 10–15 the lateral axillary buds along the infected stem have abnormally enlarged by the stimulation of the fungus and have developed in several instances short, delicate, wax-like or coralloid branchlets of carmine color. Such branchlet shoot galls are beautiful objects in their vegetative condition; they constitute a noteworthy type of gall which is quite different in appearance from the more common leaf galls, produced in response to local infection of leaves. Nevertheless, the common cause of these different gall forms is well brought out by Woronin's illustrations, especially by figs. 11, 12, 13, and 15. Upon shoot galls similar to the above, there have been published *Exobasidium Andromedae* Karst. non Peck for the shoot galls of *Andromeda polifolia, E. cassiopes Peck* for the shoot gall of *Cassiope Mertensiana,* and *E. Oxycocci* Rostrup for that of *Oxycoccus palustris.*

Figures 16–18 show the flower type of gall of *Vaccinium vitis-idaea,* that is, the abnormal growth form made by individual flowers in response to the stimulation of their tissues by the fungus. That both the flower gall and the leaf gall have a common cause has been brought out well by the selection of the specimens used for figs. 16 and 17. In fig. 18 there is presented local infection of a single flower. This is important because isolated flower galls upon a new host have in some cases been regarded as *prima facie* evidence that they have been caused by a new species of *Exobasidium.*

Other host plants produce some types of galls, when infected with *Exobasidium,* which were not figured by Woronin for *Vaccinium vitis-idaea* but which are more or less common. Such gall types are:

(a) Leaf type in which scattered whole leaves of the host are infected. These leaves redden more or less on the upper side and bear on the whole under side the scurfy or felty fructification but are not notably thickened or deformed. This gall differs from the leaf spot gall of Woronin's fig. 1 merely in having the whole of the leaf infected.

(b) Shoot gall with all the leaves toward the tip of the shoot infected but not deformed. These leaves may be almost normally green on the upper side or they may be more or less reddened, sometimes to carmine red; on the under side they become clothed with the felty fructification of the fungus but the leaves are not deformed. This is merely a more general infection than the leaf type *a,* described above, and is often associated with it on the same plant as well as with the leaf spot and leaf concavity forms.

(c) Bag gall of *Andromeda ligustrina.* This is the extreme in gall production. This gall finally becomes a hollow bag which attains a maximum size of 10–15 cm. in length by 5–10 cm. in diameter. These bag galls are either terminal or lateral on leafy shoots of the current season's growth. When lateral, such a gall has the morphological position of a leaf.

(d) Bud gall of *Symplocos tinctoria.* The expanding leaf buds are deformed into a subglobose mass which may be 3–3½ cm. in diameter. In this gall, the undeveloped stem of the bud is greatly enlarged and the individual leaves of the bud are greatly thickened and deformed.

In North America, we have a large number of species of *Ericaceae* which produce galls when infected by *Exobasidium.* The specimens which have accumulated under *Exobasidium* in herbaria show that none of the gall forms which I have designated under distinctive names in the preceding paragraph are isolated forms. Favorable hosts show a connection and gradation between the various gall forms as intimate as that presented by Woronin for *Vaccinium vitis-idaea.* However, the terms which I employ are useful for contrasting and comparing the data presented by the specimens which I have studied. These data are later given in tabular form.

The microscopic examination of an Exobasidium gall shows that it is composed principally of the tissues of the host plant. Hyphae of the fungus ramify about between the cells of the host and, in the galls in which deformation has taken place, the presence of the fungous hyphae has caused the host both to multiply and enlarge its cells in the infected region. The gall is, therefore, a direct product of the host plant, which is stimulated to growth by the presence of the parasitic vegetative hyphae, by absorption of organic products from the host, and, undoubtedly, by excreta from the hyphae. We may see from Woronin's figures that the various organs of a given host produce different galls when infected by the same fungus; from which we may conclude that the several organs of the host make different growth responses to the same stimulating cause. We have in the host itself, in its several organs, and also in the age of tissues of these organs, as I shall point out later, factors not only able to produce, but actually producing, diversity in gall form even though but a single species of *Exobasidium* is the parasitic stimulant. Of what value, then, is the form of the gall as a taxonomic character for species of *Exobasidium?*

The different organs of the host differ in the resistance which they offer to infection by *Exobasidium.* Woronin notes in his work cited that out of more than a thousand specimens of *Exobasidium Vaccinii,* only twelve showed flower galls. Hence the flowers of *Vaccinium vitis-idaea* are much less subject to infection than the leaves. In only the one case, which he illustrates by fig. 18, did he observe local infection of a flower. In figs. 16 and 17, the infected flowers are borne on infected shoots and may have become infected through these shoots. We may therefore conclude that in a given host a high resistance of certain organs to infection by *Exobasidium* restricts the galls for that host to fewer organs and to a smaller number of forms than in some other host with a lesser resistance.

That the age of the organs, or their cells, of a host is an important factor in the determination of gall form is apparent if one observes throughout a season the succession of galls produced by a favorable host. In this connection Richards[1] has stated, "and also on Gaylussacia resinosa in the earliest formed distortions, whole shoots are transformed. Later in the season the Exobasidium forms only slight local distortions on the leaves, and still later one finds forms which do not distort the tissues of the host plant at all, but simply form a

[1]Bot. Gaz. 21 : 107. 1896.

scurf on the lower side of the leaves. The same succession is found in the forms on Andromeda down to the last mentioned.'' Richards determined by culture experiments that the remarkable bag galls of *Andromeda ligustrina* are merely early (June in Massachusetts) productions under the same specific fungous stimulus which later in the season induces leaf concavities on this host. The account of his experiments[1] may be summarized as follows: During July, Exobasidium spores were removed with suitable precautions from fresh mature bag galls of *Andromeda ligustrina* and were immediately transferred to buds and young leaves of experimental plants of the same species, which were isolated in a moist chamber. In about ten days faint discolorations of the leaves were noticed, at first yellowish and then pink. About five days later, the spots which had considerably enlarged, began to show unmistakable signs of thickening, forming the peculiar concavities in the leaves seen in other Exobasidia. In external form, and also in the matter of basidia and spores, this distortion resembled precisely the leaf form on *Andromeda ligustrina,* and indicates that the *Exobasidium* which produces the bag galls of the young buds is identical with the fungus which produces the leaf form found later in the season.

The foregoing presentation of the Exobasidium gall as a growth response of the host under stimulation by the fungus shows that very different forms of galls and differences in regard to abundance of each form on a host may result—

(a) From the different organs making the response.

(b) From differences in resistance of the several organs, which, in many cases, may undoubtedly be so great as to give complete immunity for certain organs.

(c) From the age of the organ attacked.

Since the host produces a great variety of gall forms as growth responses to attack by a single species of *Exobasidium,* how are we to decide whether a given gall form is ever sufficiently distinct to entitle its causative organism to separate specific rank? Gall forms are host products to so large an

[1] *loc. cit.*, p. 105.

extent that they can have little, if any, value for discriminating between species of *Exobasidium.* Into the formation of such galls so many other factors besides the Exobasidium hyphae enter that it is impossible to consider galls as homologous with the fructification of an ascomycete or that of a toadstool, and they should not be used therefore in the way these true fungous fructifications are used for affording in their form specific characters. As a matter of fact, the layer of basidia and conidia-bearing hyphae at the outside of the gall comprise the whole fructification of the parasitic fungus; this layer alone is morphologous with a toadstool. The mere form of the foreign substratum covered by the resupinate fructification of *Exobasidium* should have no greater taxonomic weight than it has in the closely related genus *Corticium.*

We should now consider the distribution of *Exobasidium Vaccinii* as a parasite upon various genera and species of the *Ericaceae.* Woronin limited his investigation of *E. Vaccinii* to what he observed on *Vaccinium vitis-idaea* and left the matter there for other investigators to go on with, if they were so disposed. As the collections which are made on this host nearly always show the fungus occurring in leaf spot galls and leaf concavity galls, and since these forms of galls are the only ones on this host common enough for distribution in published exsiccati, the species *Exobasidium Vaccinii* seems to have become altogether too closely associated with, and limited in mycological practice to, merely the very commonest gall forms which are produced under stimulation by *E. Vaccinii.* For example, Shear[1] states, "The typical form of *Exobasidium Vaccinii* occurs on *Vaccinium vitis-idaea,* producing hypertrophied spots on the leaves. No record has been found of the occurrence of hypertrophied shoots on this host similar to those found on cranberry plants. Rostrup[51] seems to have been the first to describe this form. In 1883 he reported it as occurring on *Oxycoccus palustris* in Denmark."

[1] Cranberry Diseases. U. S. Dept. Agr., Bur. Pl. Ind., Bul. 110: 36. 1907.

Without doubt, this misapprehension of the galls produced by *Vaccinium vitis-idaea* is due to the scarcity of copies of Woronin's original account of *Exobasidium Vaccinii,* for Woronin is at great pains to show that to *E. Vaccinii* are due both shoot galls and flower galls.

That the erroneous tendency of limiting to *E. Vaccinii* the production of only the commonest leaf galls is potent, is apparent from inspection of the table towards the close of this paper where under the heading, "Exobasidium Vaccinii (Fuck.) Wor. The following have been referred here invariably" there are grouped all Exobasidium galls produced by *Vaccinium vitis-idaea, V. vacillans, V. arboreum, V. pennsylvanicum, V. stamineum, Gaylussacia frondosa, G. resinosa, Arctostaphylos uva-ursi, A. nevadensis, Arbutus Menziesii, Rhododendron canadense, R. maximum,* and *Lyonia jamaicensis.*

Our *Gaylussacia frondosa* and *G. resinosa* of this list merit some detailed consideration for they compare very favorably with *Vaccinium vitis-idaea* as hosts for *Exobasidium Vaccinii.* The galls of these two species of *Gaylussacia* include during the season two shoot forms, leaf concavity type, leaf spot type, and the flower type. The flower type of gall is probably very rare; I have seen a dried herbarium specimen of it collected by Dr. Farlow, at Brewster, Massachusetts, and two others, preserved in alcohol in Seymour Herbarium, one of which was collected by A. B. Seymour, at Woods Hole, Massachusetts, and the other by Mrs. Pier, at Biddeford, Maine. These flower galls have a diameter of 10–12 mm.; all the floral organs are enlarged as in case of the flower galls illustrated by Woronin. Bartholomew collected and distributed in his 'Fungi Columbiani,' 3429, the shoot gall of the wax-like or coralloid type such as is produced by *Vaccinium vitis-idaea. Gaylussacia resinosa* very frequently produces as its earliest galls the other form of shoot gall with all the leaves felty on the whole under surface, more or less reddened above, and not deformed. Such a shoot gall is produced by *Vaccinium Myrtillus* in Europe; it has usually been regarded by European mycologists as due to *Exobasidium Vaccinii.* Its regular occurrence in North America in a series of *E. Vaccinii* forms confirms the correctness of the reference.

As we take up the consideration of North American species of *Exobasidium* which have been published since 1867, we find that in nearly all cases peculiarities of galls have furnished the distinctive portion of the description. These odd or striking forms of galls have been discovered upon new hosts, as was to be expected, for a new host species would without doubt have composition and properties at least slightly different from those of *Vaccinium vitis-idaea*—so different that the growth response, i. e., the gall of this new host, might differ somewhat, perhaps differ notably, from that of *V. vitis-idaea,* even though the stimulus should be given by the same fungus. Two of the specific names to be considered are based entirely upon the occurrence of *Exobasidium* on a new host, and the other eight are founded upon more or less noteworthy galls. Reference to the second division of my table shows that gall form rather than host has caused the publication of specific names in *Exobasidium.*

Exobasidium Peckii, for example, was published as the cause of flower galls produced by *Andromeda Mariana.* Its flower galls are produced so frequently that they attracted attention; leaf concavity galls are common here also. The morphological characters of the fungous cause of these galls agree closely with those of *Exobasidium Vaccinii,* and the galls themselves are of types that *Vaccinium vitis-idaea* produces under stimulation by *Exobasidium Vaccinii.* No evidence of any nature has been offered tending to show that *E. Peckii* is not *E. Vaccinii* in all respects. The frequent production of flower galls by *Andromeda Mariana* can be simply accounted for as due to the susceptibility of the young flower to infection by the fungus, that is, to a special property of this host. I regard *Exobasidium Peckii* as a synonym of *E. Vaccinii.*

In connection with the discussion of *E. Peckii,* attention should be called to occasional flower galls produced by *Lyonia* (*Andromeda*) *ferruginea.* I have seen only four specimens of these galls, two from Georgia and two from Florida. All resemble monstrous flowers—up to 5 cm. long in the dried state—with all floral organs enlarged proportionally, as in the flower galls of *Andromeda Mariana, Gaylussacia resinosa,* and *Vaccinium vitis-idaea.* Only flower galls are as yet known to me for *Lyonia ferruginea,* but as the morphological characters of the fungus found on the galls are those of *Exobasidium Vaccinii,* I regard these galls as similar to those of *Andromeda Mariana* but much larger and due to *Exobasidium Vaccinii.* The large size of these Lyonia galls is the expression of the growth response of the flower tissue of this host. It will be interesting if further collections of this host show that only the flowers are susceptible to infection by *Exobasidium.*

Exobasidium Oxycocci was proposed as a name for the fungus causing the shoot galls of wax-like or coralloid habit which are produced by *Oxycoccus palustris.* Similar galls are produced in the United States by *Vaccinium macrocarpon* and *V. intermedium.* Shoot galls of *V. macrocarpon* are illustrated in color by Shear[1] and also the leaf spot and leaf concavity galls which this host produces. The morphological characters of the fungus producing the shoot galls on the cranberry species of *Vaccinium* are the same as those of *Exobasidium Vaccinii;* the galls produced by cranberry plants are such as *E. Vaccinii* produces. As there is no evidence of any kind that *E. Vaccinii,* common throughout the same region, does not cause the cranberry galls, the name *E. Oxycocci* seems quite unnecessary.

Exobasidium Cassiopes and *E. Karstenii* have been published as causes of the shoot galls produced by *Cassiope Mertensiana* and *Andromeda polifolia* respectively. These shoot galls are of the wax-like or coralloid type such as *Vaccinium vitis-idaea* produces under stimulation by *Exobasidium Vaccinii.* As the morphological characters of the so-called *E. Cassiopes* and *E. Karstenii* are those of *E. Vaccinii,* and as no evidence has ever been presented that *E. Vaccinii* does not cause the galls referred to, *E. Cassiopes* and *E. Karstenii* should also be regarded as synonyms of *E. Vaccinii.*

[1] *loc. cit., pl. 8.*

Exobasidium Andromedae Peck is based on the bag gall produced by *Andromeda ligustrina.* This gall described in detail on a preceding page, is so very large and remarkable in structure that it did seem that here, if anywhere, must be the anomaly for higher fungi of a fungous cause, specifically different from *Exobasidium Vaccinii,* yet having the same morphological characters. From this point of view, Richards' experiment,[1] already described, of growing on the leaves of *Andromeda ligustrina* a July crop of leaf concavity galls from spores produced by a bag gall which had matured at the beginning of July, was very illuminating. It showed that such a bag gall is noteworthy only because it shows peculiar properties inherent early in the season in shoots and leaves of *Andromeda ligustrina,* that this bag gall belongs in the series with, and is caused by, the same fungus as the leaf concavity galls such as *Exobasidium Vaccinii* produces.

Richards made other experiments tending to show that *E. Vaccinii* produces the bag galls on *Andromeda ligustrina.* He demonstrated that the latter species is not immune to undoubted *Exobasidium Vaccinii,* that it is as susceptible to such spores as to those produced by its own bag galls. In July, spores of *E. Vaccinii* gathered from leaf concavity galls of *Gaylussacia resinosa* were transferred to buds and young leaves of *Andromeda ligustrina.* After about the same lapse of time as when spores from the bag galls were used, there appeared on the Andromeda leaves infected with *Exobasidium Vaccinii* distortions very similar to those produced by spores from the bag galls. As the large bag gall was the only occasion for the name *E. Andromedae* Peck, I agree with Richards that this name is a synomym of *E. Vaccinii.*

In confirmation from the herbarium side of the correctness of the above conclusion, I have a specimen collected in Idaho by Professor Piper, 772, on *Menziesia glabella,* which has a small terminal bag gall such as is produced by *Andromeda ligustrina,* and also a leaf concavity gall.

In the light of what we now know about bag galls the names *Exobasidium Azaleae, E. discoideum,* and *E. Rhododendri*

[1] *loc. cit.*

appear superfluous, for their galls pass through the concavity stage and the morphological characters of the fungi concerned differ in no respect from those of *E. Vaccinii.*

Exobasidium Cassandrae was based on a leaf concavity of *Cassandra calyculata.* The new host was the sole basis for this new name and its author closed his description with the comment, "perhaps this is only a form of E. Vaccinii." Since we now regard *E. Vaccinii* as able to infect many species of the *Ericaceae,* the host alone in this case (with the morphological characters of the fungus agreeing with those of *E. Vaccinii*) does not afford sufficient justification for regarding *E. Cassandrae* as distinct from *E. Vaccinii.*

Exobasidium Arctostaphyli was founded on a leaf spot on *Arctostaphylos pungens.* As in the case of *Exobasidium Cassandrae,* there is no evidence whatever that the fungus concerned is not *E. Vaccinii,* the characters of the fungus and its work being quite those of the latter species.

The usual errors in connection with the preceding series of synonyms which are grouped together in the second division of my table are due, it seems to me, to attaching to a strange gall form—a host product—the same weight which one would give to a toadstool, and to ignoring the true fructifications of the *Exobasidium* concerned. In the taxonomy of the *Hymenomycetes,* species are based upon differences in morphological characters. It is so remarkable an innovation in our taxonomic usage in this group of plants to propose a new species which has precisely the same morphological characters as a well-known and established one that it makes it incumbent upon, and an unusual opportunity for, an author so establishing a species to show conclusively the truth of the paradox that actually good and distinct species of *Hymenomycetes* have the same morphological characters. In all the cases which have been considered, no evidence tending toward such proof has been offered. In the above, I but express the views of many of the best mycologists, who have consistently regarded the above-mentioned Exobasidium names as synonyms of *E. Vaccinii.*

Winter[1] wrote of *Exobasidium Vaccinii* in Europe where there is a similar confusion as to species, "der Pilz erzeugt ausnahmslos Formänderungen der verschiedensten Art an den von ihm bewohnten Pflanzentheilen . . . . . Ich finde zwischen den einzelnen verschiedene Nährpflanzen bewohnenden Formen keine wesentlichen Unterschiede."

The specimens which I have studied show that we have in North America perhaps three species of *Exobasidium,* two of which are rare and are present in herbaria in so few specimens that present conclusions concerning them are somewhat tentative. These species are as follows:

1. *E. Vaccinii* (Fuck.) Wor.

This species is common and wide-spread and is parasitic on many ericaceous host plants. There is as yet no evidence of which I am aware tending to show that so-called physiological races or forms with parasitism limited to a particular host exist in this species. This fungus attacks leaves developing leafy shoots, and flowers of susceptible plants, making its most successful infections when these organs are very young. The vegetative hyphae live in the infected organs between the cells, which are stimulated by the presence and activities of the parasitic hyphae to make a more or less marked hypertrophic growth response, termed a gall. The galls are of varied and sometimes strange form according to the host, the organ, and its age. The distribution of the galls upon the host is dependent upon the susceptibility of its various organs to infection.

In fruiting, the hyphae push through the epidermis to the surface and produce there a resupinate fructification which is amphigenous in the case of galls from tissues so young that they form galls of wax-like or coralloid structure, and hypophyllous on the more common leaf galls. The fructification is variable in thickness, consisting sometimes of scattered clusters of basidia but usually with hyphae present in variable quantity between the basidia so that the fructification may attain a maximum thickness of 60–70 μ, as in the case of col-

[1] In Rabenhorst, Krypt. Flora 1^1: 322. 1884.

lections on *Vaccinium vitis-idaea.* As shown by Richards,[1] these hyphae bear simple, acicular, conidia about $6–9\times1–1\frac{1}{2}$ μ. Conidia are nearly always present in the preparations but have been entered only occasionally in my table. The basidia are generally 4-spored. The basidiospores from herbarium specimens are colorless, simple or with some uniseptate, $10–20\times2\frac{1}{2}–5$ μ, but are usually about $12–18\times3–3\frac{1}{2}$ μ. They are sometimes a little shorter, or a little longer, or a little thinner, or a little thicker, but are so variable within the extremes stated for different collections on the same host within the same regions or distant regions—as will be seen by reference to my table—that a moderate latitude in spore dimensions seems evident.

2. *E. Vaccinii uliginosi* Boud.

The European specimen of this species distributed from Norway in Briosi and Cavara, 'Funghi Paras.,' 261, has a resupinate, hypophyllous felty fructification, 30–45 μ thick, which is composed almost wholly of large basidia, standing close together and presenting in sections the appearance of a distinct palisade layer. This fructification begins below the epidermis and tears the cells of the latter loose and apart from each other and carries them outward between the basidia. The hymenium is abundantly fruited with basidiospores, borne two to a basidium. The spores are simple, colorless, even, curved towards the base, $18–20\times6–7$ μ. No conidial hyphae could be found between the basidia in this specimen.

The specimen distributed in Eriksson, 'Fungi Par. Scand.,' 286a, has similar spores $16–20\times8$ μ. This specimen is in poorer condition and does not show basidia clearly. In some places the fructification is composed of very fine, short-celled hyphae, which are not bearing conidia. Both the above specimens are shoot galls with leaves felty below and reddened above.

Professor Piper, 443, collected on *Vaccinium membranaceum,* at Mt. Ranier, Washington, in August, a shoot gall similar to the European specimens and having a well fruited

[1] *loc. cit.*

Exobasidium with 2-spored basidia and spores 16–20×8 μ. The fungus agrees in all respects with the specimen in Briosi and Cavara, 261. Several other collections on *Vaccinium membranaceum* of buff colored leaf concavity and leaf spot galls appear to bear *Exobasidium Vaccinii.* The very thick spores, borne two to a basidium, distinguish *E. Vaccinii uliginosi* from *E. Vaccinii.*

3. *E. Symploci* Ell. & Mart.

This fungus attacks the developing leaf buds of *Symplocos tinctoria* and deforms them into a lobed mass. In fruiting, the hyphae protrude on the surface of the mass and bear acicular, simple, colorless, slightly curved conidia, ranging from about 7×1 μ upward. The largest spores are 24×2 μ, acicular, curved, and of the same form as those of intermediate size and so on down to attached conidia. I have not found any of the largest spores attached, nor have I found basidia. In the original description the reference to spore characters is "conidia hyaline, cylindric, nearly straight, 15–21×2 μ."

I conclude that basidia have yet to be demonstrated for this fungus.

As I have had an opportunity to examine a large number of Exobasidium specimens, collected in widely separated localities, on many hosts and at various times in the growing season, it has seemed that a concise summary of the data obtained in regard to each specimen might prove useful for comparison purposes to others who study our specimens of this genus in the future. Pains have been taken to give the hosts accurately. I am indebted to Dr. J. M. Greenman for aid in host determinations in several cases.

In the matter of spores the stated dimensions are those of the preparations which were studied. No effort was made to study preparation after preparation from the same collection in order to find spores possibly larger or smaller than those of the first preparation which showed the spores well. The dimensions stated are those obtained by treating all specimens in exactly the same way and give such results as herbarium specimens afford.

TABLE I

COMPARATIVE TABLE OF DATA CONCERNING SPECIMENS OF EXOBASIDIUM EXAMINED

Host	Spore measure	Gall	Date	Locality	Coll. or herb.
EXOBASIDIUM VACCINII (FUCK.) WOR. THE FOLLOWING HAVE BEEN REFERRED HERE INVARIABLY					
Vaccinium vitis-idaea	14–16.8×2.8 μ (Wor.)	Leaf spot, leaf concavity—scurfy or felty below and reddish above—shoot gall, flower gall.	May to Sept.	Russia	Woronin's article
	12–15×3–3½ μ	Leaf spot, leaf concavity—scurfy or felty below and reddish above.	July	Germany	Krieger, Fung. Sax., 62
	12–15×3 μ	Leaf concavity, felty below, red above.	Aug.	Sweden	Romell
	12–15×3–3½ μ	Same as preceding.	Aug.	Sweden	Burt
V. vacillans	12–14×3 μ	Many leaves, felty under, reddish above.	June	Mass.	Sey. & Earle, Ec. Fung., 137a
	12×2½–3 μ	Leaf spot, scurfy below, reddish above.	July	Mass.	Sey. & Earle, Ec. Fung., 137b
	12–15×3 μ	Leaf spot, felty below, red above.	July	Mass.	Sey. & Earle, Ec. Fung., 137c
	12–15×3–3½ μ	Many leaves, felty under, reddish above.	June	Md.	Barth., Fung. Col., 3324
	15×3 μ	Same as preceding.	May	D. C.	Barth., Fung. Col., 1728
	12–18×3–4 μ	Same as preceding.	May	Md.	Barth., Fung. Col., 3231
	Conidia 6–9×1 μ	Same as preceding.	May	Mo.	Mo. B. G. Hb., 4949
V. arboreum	15×3–3½ μ	Leaf spot, scurfy below, reddish above.	April	Ala.	Ala. Biol. Surv.
	12–15×3 μ	Same as preceding.	April	Ala.	Mo. B. G. Hb., 4975
V. pennsylvanicum	12–13×3 μ	Leaf spot, scurfy below, reddish above.	....	Wis.	Mo. B. G. Hb., 4985
	11–13×3 μ	Leaf spot, felty below, reddish above.	Aug.	Wis.	Mo. B. G. Hb., 44414
	Immature	Leaf spot, scurfy below, reddish above.	....	N. Bruns.	Mo. B. G. Hb., 44415
	11–13×3 μ	Same as preceding.	....	Minn.	Mo. B. G. Hb., 44416
V. stamineum	12–15×3 μ	Leaf spot, scurfy below, dark red above.	April	Ala.	Ala. Biol. Surv.
	12–15×3–4½ μ	Same as preceding.	April	Ala.	Mo. B. G. Hb., 4976
	12×3 μ	Same as preceding.	May	Ala.	Mo. B. G. Hb., 4971
	12–15×3–3½ μ	Leaf spot, scurfy below, buff and red above.	June	N. Y.	Mo. B. G. Hb., 4991

V. membranaceum	12–14×3–3½ μ	Leaf concavity, scurfy, yellowish buff.	Sept.	Wash.	Suksdorf, 448
	13–15×3 μ	Same as preceding.	Aug.	Wy.	Mo. B. G. Hb., 44413
	15–19×4–5 μ	Barely a concavity, scurfy, yellowish buff and spots red margined.	Aug.	Wash.	Suksdorf, 504
	12–18×4–5 μ	Same as noted for preceding.	Sept.	Wash.	Suksdorf, 504
	Too immature.	Leaf spot, scurfy below, yellowish.	July	Idaho	Mo. B. G. Hb., 4989
Gaylussacia frondosa	12–15×3–3½ μ	Shoot gall—all later leaves of shoot with whole of each felty below, reddish above.	June	Mass.	Bartholomew, Fung. Col., 3323
	Sterile	Leaf spot, leaf concavity, reddish above.	June	N. Y.	Mo. B. G. Hb., 4953
	12–14×3 μ	Leaf spot, leaf concavity, reddish above.	July	N. Y.	Mo. B. G. Hb., 4957
	Sterile	Leaf concavity, scurfy below, red above.	May	Fla.	Mo. B. G. Hb., 44404
	14×3 μ	Leaf spot, scurfy below, buff colored.	Sept.	Mich.	Waite, 118
	Sterile	Leaf spot, scurfy below, buff or red above.	Sept.	Mass.	Mo. B. G. Hb., 4948
G. resinosa	Immature	Whole leaves, scurfy below, reddish above.	May	Va.	Barth., Fung. Col., 3232
	Conidia 6–9×1–1½ μ	Shoot gall—whole leaves felty below, green or slightly reddened above.	May	Md.	Barth., Fung. Col., 3523
	15×3–3½ μ	Leaf concavity, felty below, red above.	May	Md.	Barth., Fung. Col., 3430
	Conidia	Leaf concavity, shoot gall of the V. vitis-idaea coralloid type.	May	Md.	Barth., Fung. Col., 3429
	Immature	Shoot gall of coralloid type, flower gall.	June	Mass.	Seymour Herb., T54
	Sterile	Leaf concavity, felty below, red above.	July	Mass.	Sey. & Earle, Ec. Fung., 488
	Conidia 6–10×1–1½ μ	Leaf concavity, shoot gall with whole leaves felty under, reddened above.	July	N. Y.	Mo. B. G. Hb., 4781
	Conidia 6–9×1 μ	Shoot gall with whole leaves felty under, reddened above.	....	Wis.	Mo. B. G. Hb., 4961

TABLE I (Continued)

Host	Spore measure	Gall	Date	Locality	Coll. or herb.
G. resinosa —continued	10–12×$2\frac{1}{2}$–3 μ Conidia 6–9×1–$1\frac{1}{2}$μ	Shoot gall of coralloid type, leaf concavity, flower gall.	July	Maine	Seymour Herb., T55
	Conidia 6–8×1 μ	Shoot gall with whole leaves felty below.	....	....	Mo. B. G. Hb., 4946
Arctostaphylos uva-ursi	Sterile	Shoot gall with all leaves felty below, reddened above.	July	Wash.	Piper, 434
	12–15×3 μ	Shoot gall of the V. vitis-idaea coralloid type.	Aug.	Col.	Barth, Fung. Col., 2729
A. manganita	12×3 μ	Whole leaves felty below, reddened above.	July	Cal.	Seymour Herb.
A. nevadensis	16×$4\frac{1}{2}$ μ	Shoot gall of coralloid type.	July	Wash.	Suksdorf, 840
	12–14×3 μ	Shoot gall with all leaves felty below, dark red above.	Aug.	Wash.	Piper, 428
Arbutus Menziesii	12–15×2–4 μ	Leaf concavity, felty below, red above.	....	Cal.	Ell. & Ev., N. Am. F., 1586b
Lyonia jamaicensis	15×$3\frac{1}{2}$ μ	Leaf concavity to leaf bags, drying reddish brown.	March	Jamaica	Mo. B. G. Hb., 44403
Rhododendron albiflorum	Spores soon 3-septate 15–22×4–6 μ Basidia 4-spored 12–20×4–5 μ and as above	Leaf spots, scurfy below, buff colored.	Sept.	Wash.	Suksdorf, 841
		Leaf spots, scurfy below, buff colored.	Sept.	Wash.	Suksdorf, 449
R. canadense	Conidia	Leaf spot, scurfy below, reddish above.	Sept.	Newf.	Mo. B. G. Hb., 42608
		Same as preceding.	Aug.	Newf.	Mo. B. G. Hb., 4981
R. maximum	12–15×4 μ	Leaf concavity, red.	July	N. Car.	Mo. B. G. Hb., 4951

EXOBASIDIUM VACCINII (FUCK.) WOR. THE FOLLOWING SYNONYMS ARE BASED ON GALL FORMS AS STATED:

Exobasidium Azaleae Peck, = E. discoideum Ell.					
Azalea nudiflora	15–16×3 μ	Terminal bags, lateral leaf bags.	May	Ala.	Ala. Biol. Surv.
	13–18×3–4½ μ	Leaf bag, scurfy leaf spots, reddish above.	May	Ala.	Mo. B. G. Hb., 4964
	Sterile	Leaf bag suspended by a point.	April	Ala.	Mo. B. G. Hb., 4963
	Sterile	Flowers modified into obconic galls.	June	Mass.	A. B. Seymour Herb.
A. cult. sp.	12–15×3–3½ μ	Flower and leaf bag galls.	June	Mass.	Sey. & Earle, Ec. Fung., 489
A. viscosa	13–18×3–3½ μ	Bag gall, suspended from leaf.	July	N. J.	E. & Ev., N. Am. F., 1718
	Sterile	Bag gall, suspended from leaf.	May	Miss.	Mo. B. G. Hb., 4970
	Conidia	Flower and leaf bag galls.	April	Miss.	Mo. B. G. Hb., 4960
	Sterile	Bag gall, suspended from leaf.	Aug.	Mass.	Mo. B. G. Hb., 44405
	18×3½ μ	Leaf spots, scurfy below, reddened above.	Sept.	Mass.	Mo. B. G. Hb., 44410
Exobasidium Rhododendri Cramer					
Rhododendron ferrugineum	12–15×3–3½ μ	Leaf concavity, bag gall suspended from leaf.	Sept.	Switz.	Rabenhorst, Fung. Eur., 1910
	13–15×3–4 μ	Bag gall, suspended from leaf.	Sept.	Germ.	Magnus, Mo. B. G. Hb.
	14×3 μ	Bag gall, suspended from leaf.	Aug.	Austria	Magnus, Mo. B. G. Hb.
	Sterile	Bag gall, suspended from leaf.	Aug.	Switz.	Kunze, Fung. Sel. Ex. 302
Exobasidium Peckii Halst.					
Andromeda Mariana	12–13×3 μ	Leaf concavity, reddened above; flower gall—flower organs all enlarged.	May	Fla.	A. B. Seymour Herb.
	11–15×3 μ	Same gall forms as the preceding.	May	Fla.	Mo. B. G. Hb., 4966
	12–18×3–4 μ	Same gall forms as the preceding.	June	N. Y.	Sey. & Earle, Ec. Fung., 487
	12–18×3–3½ μ	Leaf concavity, felty below, reddened above.	June	N. J.	Ell. & Ev., Fung. Col., 1210
	Conidia 6–9×1–1½ μ	Leaf concavity, reddened above.	June	Fla.	Mo. B. G. Hb., 4954
Lyonia ferruginea	16–18×4 μ	Flower gall, 2½×2½ cm.—all the organs present and proportionately enlarged.	May	Ga.	U. S. Dept. of Agr.

TABLE I (Continued)

Host	Spore measure	Gall	Date	Locality	Coll. or herb.
Lyonia ferruginea —continued	15×3½–4 μ	Same as above—3–5 cm. long, 1–2½ cm. thick.	June	Ga.	Mo. B. G. Hb., 4955
	12×3½ μ	Flower gall of same type as preceding.	April	Fla.	Mo. B. G. Hb., 4962
		Flower gall of same type as preceding.	....	Fla.	Mo. B. G. Hb., 44409
Exobasidium Andromedae Peck					
Andromeda ligustrina	15–18×3–3½ μ	Bag gall, terminal on shoot.	June	Mass.	H. L. Jones
	15–18×3–3½ μ	Bag gall, terminal on shoot.	June	Mass.	Rush.
	Conidia	Bag gall, terminal on shoot.	June	Mass.	Duggar, Mo. B. G. Hb.
	17×3½ μ	Leaf bag, terminal bag.	June	N. Y.	Shear, N. Y. Fung., 117
	12–16×3 μ	Bag gall, terminal on shoot.	....	N. J.	Ellis, N. Am. Fung., 107
	12–15×3½–4 μ	Bag gall in the place of a leaf.	April	Fla.	Mo. B. G. Hb., 44326
Menziesia glabella	{ 10–13×2–2½ μ 10–18×1½–2½ μ	Bag gall, terminal on shoot. Leaf concavity of E. Vaccinii type. }	Aug.	Idaho	Piper, 772
Exobasidium Cassandrae Peck					
Cassandra calyculata	12–15×3–4 μ	Leaf concavity, felty below, red above.	....	N. Y.	Peck, Ellis N. Am. F. 722
	12–15×3–4½ μ	Leaf concavity, scurfy below, red above.	....	N. Y.	Clinton
	15×3½ μ	Leaf concavity, felty below, red above.	Aug.	Canada	Ell. & Ev. N. Am. F., 2312a
	{ 15×3–4½ μ 12×3 μ	Leaf concavity, felty below, red above. Whole leaf, felty below, red above. }	July	Mich.	Trelease, Mo. B. G. Hb.
	Conidia	Shoot gall—all leaves felty under, reddish above.	....	Newf.	Robinson & von Schrenk, Mo. B. G. Hb.
	14×3½ μ	Leaf spot, felty below, red above.	July	Russia	Fung. Rossiae Ex. 72
Exobasidium Arctostaphyli Harkn.					
Arctostaphylos pungens	12–17×3–5 μ	Leaf spot, scurfy below, red above.	....	Cal.	Ell. & Ev., N. Am. F. 1586a
	12–18×4½ μ	Leaf spot, scurfy below, red above.	....	Cal.	Harkness, Mo. B. G. Hb.

Exobasidium Cassiopes Peck					
Cassiope Mertensiana	12–13×3 μ	Shoot gall of the V. vitis-idaea coralloid type.	Aug.	Wash.	Suksdorf, 501
	12–13×3 μ	Shoot gall like the preceding.	Aug.	Wash.	Piper, 771
Exobasidium Oxycocci Rostrup					
Vaccinium macrocarpon	{ 15×3–3½ μ { Conidia 6–9×1–1½ μ	Shoot gall of the V. vitis-idaea coralloid type.	....	Mass.	Minns in U. S. Dept. of Agr. Hb.
	12–15×3 μ	Shoot gall like the preceding.	Sept.	Mass.	Trelease, Mo. B. G. Hb.
	12×3 μ	Leaf spot, leaf concavity, scurfy, red above.	Aug.	Mass.	Ell. & Ev., N. Am. F. 2312b
V. intermedium	12–14×3 μ	Shoot gall of coralloid type.	June	Wash.	Piper, 39
Exobasidium Karstenii Sacc. & Trott. = E. Andromedae Karst. non Peck					
Andromeda polifolia	12×3 μ	Shoot gall, coralloid—all the leaves reddish livid.	July	Finland	Karsten
	12–15×3 μ	Shoot gall like the preceding	July	Finland	Thuem., Myc. Univ. 1110
	Sterile	Shoot gall like the preceding.	June	N. H.	Mo. B. G. Hb., 4778
Exobasidium Vaccinii myrtilli (Fuck.) Juel					
Vaccinium Myrtillus	13–15×3 μ	Shoot gall with all leaves felty below, reddened above.	June	Germany	Krieger, Fung. Sax. 665
	Conidia 6–9×1–1½ μ	Shoot gall like the preceding.	May	Germany	Thuem., Myc. Univ. 115
V. uliginosum	12–15×3–4½ μ	Leaf concavity; shoot gall like above.	July	Germany	Krieger, Fung. Sax., 768
	12–14×3 μ	Shoot gall with all leaves felty below, reddish above.	....	Finland	Karsten
	10–12×3 μ	Shoot gall like the preceding.	....	Sweden	Eriksson, Fung. Par., 286b
V. deliciosum	{ 11–12×3 μ { Conidia 6–8×1 μ	Shoot gall like the preceding.	Aug.	Wash.	Piper, 842
V. sp.	12–14×3–3½ μ	Shoot gall redder above than preceding.	Sept.	Wash.	Suksdorf, 447

TABLE I (Continued)

Host	Spore measure	Gall	Date	Locality	Coll. or Herb.
EXOBASIDIUM VACCINII ULIGINOSI BOUD.					
Vaccinium uliginosum	18–20×6–7 μ Basidia 2-spored	Shoot gall with all leaves felty below, red above.	Aug.	Norway	Briosi & Cavara, Fung. Par., 261
V. Myrtillus	15–17×7–8 μ	Shoot gall like the preceding.	....	Norway	Eriksson, Fung. Par., 286a
V. membranaceum	16–20×8 μ Basidia 2-spored	Shoot gall like the preceding.	Aug.	Wash.	Piper, 443
EXOBASIDIUM SYMPLOCI ELLIS & MART.					
Symplocos tinctoria	7–14×1½–2 μ, perhaps all are conidia	Leaf bud gall, mass 3×2 cm.	March	Fla.	Ell. & Ev., N. Am. F., 1696
	As above	Same as preceding.	March	Fla.	Mo. B. G. Hb., 4968
	8–24×1½–2 μ, perhaps all are conidia	Same as preceding.	April	Ala.	Mo. B. G. Hb., 4969
	Immature	Same as preceding.	April	Ind.	Rhodes, Mo. B. G. Hb.

Systematic Summary

1. **Exobasidium Vaccinii** Fuck. ex. Wor. Naturforsch. Ges. Freiburg Verhandl. **4**: 397–416. *pl. 1–3.* 1867. Plate 21.

Fusidium Vaccinii Fuck. Bot. Zeit. **19**: 251. 1861.—*Exobasidium Andromedae* Peck, Buffalo Soc. Nat. Hist. Bul. **1**: 63. 1873; N. Y. State Mus. Rept. **26**: 73. 1874.—*E. Azaleae* Peck, Buffalo Soc. Nat. Hist. Bul. **1**: 63. 1873; N. Y. State Mus. Bul. **26**: 72. 1874.—*E. discoideum* Ellis, Torr. Bot. Club Bul. **5**: 46. 1874.—*E. Rhododendri* Cramer in Rabenh. Fung. Eur. 1910. 1875.—*E. Andromedae* Karst. in De Thuemen, Myc. Univ. 1110. 1878; Finland Natur och Folk Bidrag **37**: 153. 1882.—*E. Karstenii* Sacc. & Trott. in Sacc. Syll. Fung. **21**: 420. 1912.—*E. Cassandrae* Peck, N. Y. State Mus. Bul. **29**: 46. 1874.—*E. Arctostaphyli* Harkn. Calif. Acad. Sci. Bul. **1**: 30. 1884.—*E. Myrtilli* (Thuem.) Karst. Finlands Natur och Folk Bidrag **37**: 152. 1882.—*E. Vaccinii Myrtilli* (Fuck.) Juel, Svensk. Bot. Tids. **6**: 364. 1912.—*E. Oxycocci* Rostr. Bot. Tidsskr. **14**: 243. 1885.—*E. Cassiopes* Peck, N. Y. State Mus. Rept. **45**: 24. 1893.—*E. Peckii* Halst. Torr. Bot. Club Bul. **20**: 437. 1893.

Illustrations: Woronin. *loc. cit.*—Richards, Bot. Gaz. **21**: *pl. 6. f. 1–20.*—Petri, Ann. Myc. **5**: 342–346.—Brefeld, Untersuch. Myk. **8**: *pl. 1. f. 17–22.*—Duggar, Fung. Dis. *f. 215, 216.*—Shear, U. S. Dept. Agr., Bur. Pl. Ind. Bul. 110: *pl. 7. f. A–D.*—Juel, Svensk. Bot. Tids. **6**: 353–372. *f. A–C.*—Engl. & Prantl, Nat. Pflanzenfam. (**I.** 1**) : 104. *f. 65.*—Other illustrations in many text-books. References to other illustrations in Sacc. Syll. Fung. **19**: 694.

Fructifications hypophyllous or amphigenous, resupinate, effused, scurfy or felty and compact, grayish, consisting of somewhat scattered clusters of basidia or of basidia and fine, suberect, more or less interwoven and branched hyphae which bear conidia and give to the fructification a maximum thickness ranging up to 60–70 μ; basidia with 4 sterigmata usually; basidiospores colorless, simple or with some 1-septate, $10–20\times2\frac{1}{2}–5$ μ, but usually about $12–18\times3–3\frac{1}{2}$ μ, becoming 3-septate in germinating; conidia simple, $6–9\times1–1\frac{1}{2}$ μ.

Parasitic in leaves, young shoots, and flowers of various ericaceous hosts, and stimulating the infected parts to the production of leaf, shoot, or flower galls which bear the fructifications on their surface. Leaf galls are usually somewhat reddish on the upper side and bear the fructification on the lower side.

From Newfoundland to Florida and westward to California and Washington, also in Jamaica.

I have referred here, with some doubt, the *Exobasidium* causing yellow-buff leaf spot galls on *Rhododendron albiflorum,* collected on mountains in Washington by W. N. Suksdorf. The basidia are 20–30×6 μ, with 4 prominent sterigmata; the basidiospores are mostly 18–21×4½–6 μ, and are nearly all 3-septate. Some of these spores are germinating, hence the septation of the spores may possibly be due to their over maturity when collected, combined with weather conditions at that time favorable to germination. Other collections which show the full series of gall forms on this host are desirable and should give the needed information in regard to septation of the spores.

Specimens examined:

Exsiccati: Ellis, N. Am. Fung., 107, 722; Ell. & Ev., N. Am. Fung., 1586a, 1586b, 1718, 2312a, 2312b; Ell. & Ev., Fung. Col., 220, 1210; Bartholomew, Fung. Col., 1728, 2729, 3231, 3232, 3323, 3324, 3429, 3430, 3523; Seymour & Earle, Econ. Fung., 137a, 137b, 137c, 487, 488, 489; Shear, N. Y. Fung., 117; De Thuemen, Myc. Univ., 115, 210, 1110, 1808; Eriksson, Fung. Par., 286b; Jaczewski, Komarov & Tranzschel, Fung. Rossiae Ex., 72; Kunze, Fung. Sel. Ex., 302; Krieger, Fung. Sax., 62, 665, 768; Rabenhorst, Fung. Eur., 1910; Romell, Fung. Scand., 38.

Austria: On *Rhododendron ferrugineum,* Tyrol, *P. Magnus* (in Mo. Bot. Gard. Herb., 4988).

Germany: On *Vaccinium vitis-idaea,* Königstein, *Krieger,* Krieger, Fung. Sax., 62; Bavaria, *De Thuemen,* Myc. Univ., 910; on *Rhododendron ferrugineum, P. Magnus;* on *Vaccinium Myrtillus,* Leipzig, *G. Winter,* De Thuemen, Myc.

Univ., 115; Königstein, *Krieger,* Fung. Sax., 665; on *V. uliginosum,* Altenberg, *Krieger,* Fung. Sax., 768.

Russia: On *Cassandra calyculata,* Novgorod, Jaczewski, Fung. Rossiae Ex., 72.

Finland: On *Vaccinium uliginosum,* Mustiala, *P. A. Karsten;* on *Andromeda polifolia,* Mustiala, *P. A. Karsten;* and also in De Thuemen, Myc. Univ., 1110.

Sweden: On *Vaccinium vitis-idaea,* Femsjö, *L. Romell; Upsala, E. A. Burt;* on *Andromeda polifolia, L. Romell,* Romell, Fung. Scand., 38; on *Vaccinium uliginosum,* Eriksson, Fung. Par. Scand, 286b.

Switzerland: On *Rhododendron ferrugineum,* Luzern, *G. Winter* in Kunze, Fung. Sel. Ex., 302; same host, Maderaner Thal, *Cramer,* Rabenhorst, Fung. Eur., 1910.

Canada: on *Cassandra calyculata,* London, *J. Dearness,* Ell. & Ev., N. Am. Fung., 2312a.

Newfoundland: on *Cassandra calyculata,* Pennie's River, *B. L. Robinson & H. von Schrenk* (in Mo. Bot. Gard. Herb., 4779); on *Rhododendron canadense,* Bluff Head, *A. C. Waghorne, 940* (in Mo. Bot. Gard. Herb., 42608); Virginia Water, *B. L. Robinson & H. von Schrenk* (in Mo. Bot. Gard. Herb., 4981).

New Brunswick: on *Vaccinium pennsylvanicum, Hays, 16* (in Mo. Bot. Gard. Herb., 44415).

Maine: on *Gaylussacia baccata,* Biddeford, *Mrs. A. M. Pier* (in Seymour Herb., T55).

New Hampshire: on *Andromeda polifolia,* Shelburne, *H. von Schrenk* (in Mo. Bot. Gard. Herb., 4778).

Massachusetts: on *Vaccinium vacillans,* Arlington, Magnolia, and Medford, *A. B. Seymour,* Sey. & Earle, Econ. Fung., 137a, 137b, 137c respectively; Plymouth, *E. Bartholomew,* Fung. Col., 3324; Weston, *A. B. Seymour, T56* (in Seymour Herb.); Rafes Chasm, *A. B. Seymour, T58* (in Seymour Herb.); Middlesex Falls, *J. G. Jack* (in Seymour Herb.); on *V. macrocarpon,* Woods Hole, *W. Trelease* (in Mo. Bot. Gard. Herb., 4982); Chatham, *Miss Minns,* and also (in U. S. Dept. Agr. Herb.); Harwich, *B.D.Halsted,* Ell.& Ev.,N.Am. Fung., 2312b; Waverly, *A. B. Seymour, T60* (in Seymour

Herb.); on *V. pennsylvanicum,* Rafes Chasm, *A. B. Seymour T59* (in Seymour Herb.); on *Gaylussacia frondosa,* Woods Hole, *W. Trelease* (in Mo. Bot. Gard. Herb., 4948); Plymouth, *E. Bartholomew,* Fung. Col., 3323; on *G. resinosa,* Manchester, *W. C. Sturgis,* Sey. & Earle, Econ. Fung., 488; Falmouth, *A. B. Seymour, T53* (in Seymour Herb.); Woods Hole, *A. B. Seymour, T54* (in Seymour Herb.); Dartmouth, *W. G. Farlow* (in Seymour Herb.); Brewster, *W. G. Farlow* (in Seymour Herb.); on *Andromeda ligustrina,* Cambridge, *Mr. Rush;* Dedham, *H. L. Jones,* and also *B. M. Duggar* (in Mo. Bot. Gard. Herb., 44411); Woods Hole, *W. Trelease* (in Mo. Bot. Gard. Herb., 44410); Hampden, *A. B. Seymour, T51* (in Seymour Herb.); Granville, *A. B. Seymour* (in Seymour Herb.); on *Rhododendron cult. sp.,* Brookline, *A. B. Seymour,* Sey. & Earle, Econ. Fung., 489; on *R. nudiflorum,* Granville, *A. B. Seymour* (in Seymour Herb.); on *R. viscosum,* Woods Hole, *W. Trelease* (in Mo. Bot. Gard. Herb., 44405, 44408).

New York: on *Vaccinium stamineum,* Ithaca, *W. Trelease* (in Mo. Bot. Gard. Herb., 4991); on *Gaylussacia frondosa,* Eastport, *J. Schrenk* (in Mo. Bot. Gard. Herb., 4953); Eastport, *H. von Schrenk* (in Mo. Bot. Gard. Herb. 4957); on *G. resinosa,* Deer Park, *H. von Schrenk* (in Mo. Bot. Gard. Herb., 4781); on *Andromeda ligustrina,* Alcove, *C. L. Shear,* N. Y. Fung., 117; on *A. Mariana,* Westbury, *F. C. Stewart,* Sey. & Earle, Econ. Fung., 487; on *Cassandra calyculata,* Adirondack Mts., *C. H. Peck,* Ellis, N. Am. Fung., 722; Buffalo, *G. W. Clinton.*

New Jersey: on *Andromeda ligustrina, Ellis,* N. Am. Fung., 107; on *A. Mariana,* Newfield, *Ellis,* Ell. & Ev., Fung. Col., 1210; on *Rhododendron viscosum,* Newfield, *Ellis,* Ell. & Ev., N. Am. Fung., 1718; and (in Mo. Bot. Gard. Herb., 4959).

Maryland: on *Vaccinium vacillans,* Rosecraft, *Bartholomew,* Fung. Col., 3231; on *Gaylussacia resinosa,* Lanham, *E. Bartholomew,* Fung. Col., 3429, 3430; *Bartholomew & Swingle,* Fung. Col., 3523.

District of Columbia: on *Vaccinium vacillans,* Takoma Park, *C. L. Shear,* Fung. Col., 1728.

Virginia: on *Gaylussacia resinosa,* Vienna, *E. Bartholomew,* Fung. Col., 3232.

North Carolina: on *Rhododendron maximum, H. von Schrenk* (in Mo. Bot. Gard. Herb., 4951); on *R. nudiflorum, H. von Schrenk* (in Mo. Bot. Gard. Herb., 4950).

Georgia: on *Lyonia ferruginea,* Brunswick, comm. by U. S. Dept. Agr. Herb.; *W. Trelease* (in Mo. Bot. Gard. Herb., 4955).

Florida: on *Gaylussacia frondosa,* Dunedin, *S. M. Tracy, 6649* (in Mo. Bot. Gard. Herb., 44404); on *Andromeda ligustrina,* St. Leo, *Rev. Jerome* (in Mo. Bot. Gard. Herb., 44326); on *A. Mariana,* White Springs, *H. H. Hume, 88* (in Mo. Bot. Gard. Herb., 4966), and also (in Seymour Herb.); *Chapman* (in Mo. Bot. Gard. Herb., 4954); on *Lyonia ferruginea, Chapman* (in Mo. Bot. Gard. Herb., 44409).

Alabama: on *Vaccinium arboreum,* Auburn, *Ala. Biol. Surv.,* and also (in Mo. Bot. Gard Herb., 4975); on *V. stamineum,* Auburn, *Ala. Biol. Surv.,* and also (in Mo. Bot. Gard. Herb., 4976); Auburn, *F. S. Earle & L. M. Underwood* (in Mo. Bot. Gard. Herb., 4971); on *Rhododendron nudiflorum,* Auburn, *Ala. Biol. Surv.,* and also (in Mo. Bot. Gard. Herb., 4964, 4963).

Mississippi: on *Rhododendron viscosum,* Ocean Springs, *F. S. Earle* (in Mo. Bot. Gard. Herb., 4970); and *S. M. Tracy* (in Mo. Bot. Gard. Herb., 4960).

Michigan: on *Galylussacia frondosa,* Lansing, *M. B. Waite, 118* (in U. S. Dept. Agr. Herb.); on *G. resinosa,* Agricultural College, *G. H. Hicks* (in Seymour Herb.); on *Cassandra calyculata,* Republic, *W. Trelease* (in Mo. Bot. Gard. Herb., 4983); Agricultural College, *G. H. Hicks* (in Seymour Herb.).

Minnesota: on *Vaccinium pennsylvanicum,* Hokal, *L. H. Pammel* (in Mo. Bot. Gard. Herb., 44416).

Wisconsin: on *V. pennsylvanicum,* La Crosse, *L. H. Pammel* (in Mo. Bot. Gard. Herb., 44414); Kirtland, (in Mo. Bot.

Gard. Herb., 4985); on *Gaylussacia resinosa,* Kirkland (in Mo. Bot. Gard. Herb., 4961).

Missouri: on *Vaccinium vacillans,* Crystal City, (in Mo. Bot. Gard. Herb., 4949).

Wyoming: on *V. membranaceum,* Teton Mts., *A. Nelson, E. Nelson, 6525* (in Mo. Bot. Gard. Herb., 44413).

Idaho: on *V. membranaceum,* Forest, Nez Perces Co., *A. A. & E. G. Heller, 3465* (in Mo. Bot. Gard. Herb., 4989); on *Menziesia glabella,* Bitter Root Mt., *C. V. Piper, 772.*

Colorado: on *Arctostaphylous uva ursi,* Glacier Lake, *Bartholomew & Bethel,* Fung. Col., 2729.

Washington: on *Vaccinium deliciosum,* Mt. Rainier, *C. V. Piper, 842;* on *V. membranaceum,* Mt. Paddo, *W. N. Suksdorf, 448;* Chiquash Mts., *W. N. Suksdorf, 504;* on *Vaccinium sp.,* probably *V. membranaceum,* Mt. Paddo, *W. N. Suksdorf, 447;* on *V. intermedium,* Seattle, *C. V. Piper, 39;* on *Arctostaphylos uva ursi,* Orchard Point, *C. V. Piper, 434;* on *A. nevadensis,* Mt. Paddo, *W. N. Suksdorf, 840;* Longwire Springs, *C. V. Piper, 428;* on *Cassiope Mertensiana,* Chiquash Mts., Skamania Co., *W. N. Suksdorf, 501;* Olympic Mts., *C. V. Piper, 771;* on *Rhododendron albiflorum,* Chiquash Mts., Skamania Co., *W. N. Suksdorf, 841;* Mt. Paddo, *W. N. Suksdorf, 449.*

California: on *Arctostaphylos pungens, H. W. Harkness* (in Mo. Bot. Gard. Herb., 4972); and also Ell. & Ev., N. Am. Fung., 1586a; on *A. manganita,* Sisson's, Siskiyou Co., *W. C. Blasdale* (in Seymour Herb.); on *Arbutus Menziesii, H. W. Harkness,* Ell. & Ev., N. Am. Fung., 1586b.

Jamaica: on *Lyonia jamaicensis,* Cinchona, *H. von Schrenk* (in Mo. Bot. Gard. Herb., 44403).

2. **E. Vaccinii uliginosi** Boud. Soc. Bot. Fr. Bul. **41**: CCXLIV. 1894.

Illustrations: Juel, Svensk. Bot. Tids. **6**: 353–372. *pl. 7. f. 5. text. f. D.*

Fructification hypophyllous, resupinate on the whole lower surface of the leaves, felty, 30–45 μ thick, composed of large basidia arranged side by side in a compact hymenium; basidia with 2 sterigmata; spores colorless, even, curved towards the base, 16–20 × 7–8 μ.

Parasitic on *Vaccinium membranaceum,* which produces shoot galls with all the later leaves of the gall red on the upper side, felty below, and but slightly, if at all, deformed.

Mt. Rainier, Washington. August.

In the original description of this species, the spore dimensions are stated as 25–32 × 8–12 μ. The European specimens in the exsiccati cited below, which European authors refer here, have spores of the dimensions of the American collection. Shoot galls of the type stated are the only form known to be caused by this species, but other forms may yet be found.

Specimens examined:

Exsiccati: Briosi & Cavara, Fung. Par., 261; Eriksson, Fung. Par. Scand., 286a under the name *Exobasidium Vaccinii.*

Norway: on *Vaccinium Myrtillus,* Eriksson, Fung. Par. Scand., 286a; on *V. uliginosum, G. von. Lagerheim,* Briosi & Cavara, Fung. Par., 261.

Washington: on *Vaccinium membranaceum,* Mt. Rainier, *C. V. Piper, 443.*

3. **E. Symploci** Ell. & Mart. Am. Nat. **18**: 1147. 1884.

Fructification amphigenous, resupinate, effused, consisting of lax, slender, colorless hyphae which bear solitary conidia at the tips of very short, lateral, ascending branches; conidia colorless, even slightly curved, acicular, 7–24×1–2 μ; basidia and basidiospores unknown.

Parasitic on *Symplocos tinctoria* which produces bud galls 3–3½ cm. in diameter, lemon yellow, subglobose and sublobate.

Florida, Alabama, and Indiana. March and April.

In the original description it is stated that the galls are distorted flower buds. In a specimen collected in Indiana, the gall is a partially developed leaf bud.

Specimens examined:

Exsiccati: Ell. & Ev., N. Am. Fung., 1696.

Florida: on *Symplocos tinctoria,* Green Cove Springs, *G. Martin* (in Mo. Bot. Gard. Herb., 4968); and in Ell. & Ev., N. Am. Fung., 1696.

Alabama: on *Symplocos tinctoria,* Auburn, *Ala. Biol. Surv.* (in. Mo. Bot. Gard. Herb., 4969).

Indiana: on *Symplocos tinctoria,* Robertsdale, *A. M. Rhodes* (in Mo. Bot. Gard. Herb., 741178).

SPECIES IMPERFECTLY KNOWN

E. decolorans Harkness, Cal. Acad. Sci. Bul. **1**: 31. 1884.

"Receptaculum effused, producing conspicuous yellowish-white, orbicular spots, 1–2 cm. in diameter, not at all distorting the leaf; spores appearing upon the under surface, hyaline, straight, μ 7–8 × 4–5.

"On living leaves of Rhododendron occidentale. Tamalpais [Cal.]. Autumn. 2887."

The above is the original description. I have seen no specimens referable here nor on the host stated.

EXCLUDED SPECIES

E. mycetophilum Peck ex Burt, Torr. Bot. Club Bul. **28**: 285–287. *pl. 23.* 1901.

Tremella mycetophila Peck, N. Y. State Mus., Bul. **28**: 53. *pl. 1. f. 4.* 1879.

This curious structure on *Collybia dryophila,* I no longer regard as parasitic but, rather, as a teratological production of *C. dryophila,* induced by protracted wet weather during development of the fructification.

(To be continued.)

Explanation of Plate

PLATE 21.

This plate is a photographic reproduction, $\times\frac{4}{5}$, of Plate 1 by Woronin[1] of the various galls produced by *Vaccinium vitis-idaea* when parasitized by *Exobasidium Vaccinii*. The original plate is colored and with all figures natural size; red colors of the original have photographed light colored.

Fig. 1. Leaf spot gall, on left side of uppermost leaf; the leaf is reddish on the upper side in the infested area, not deformed, and was felty or scurfy on the lower side.

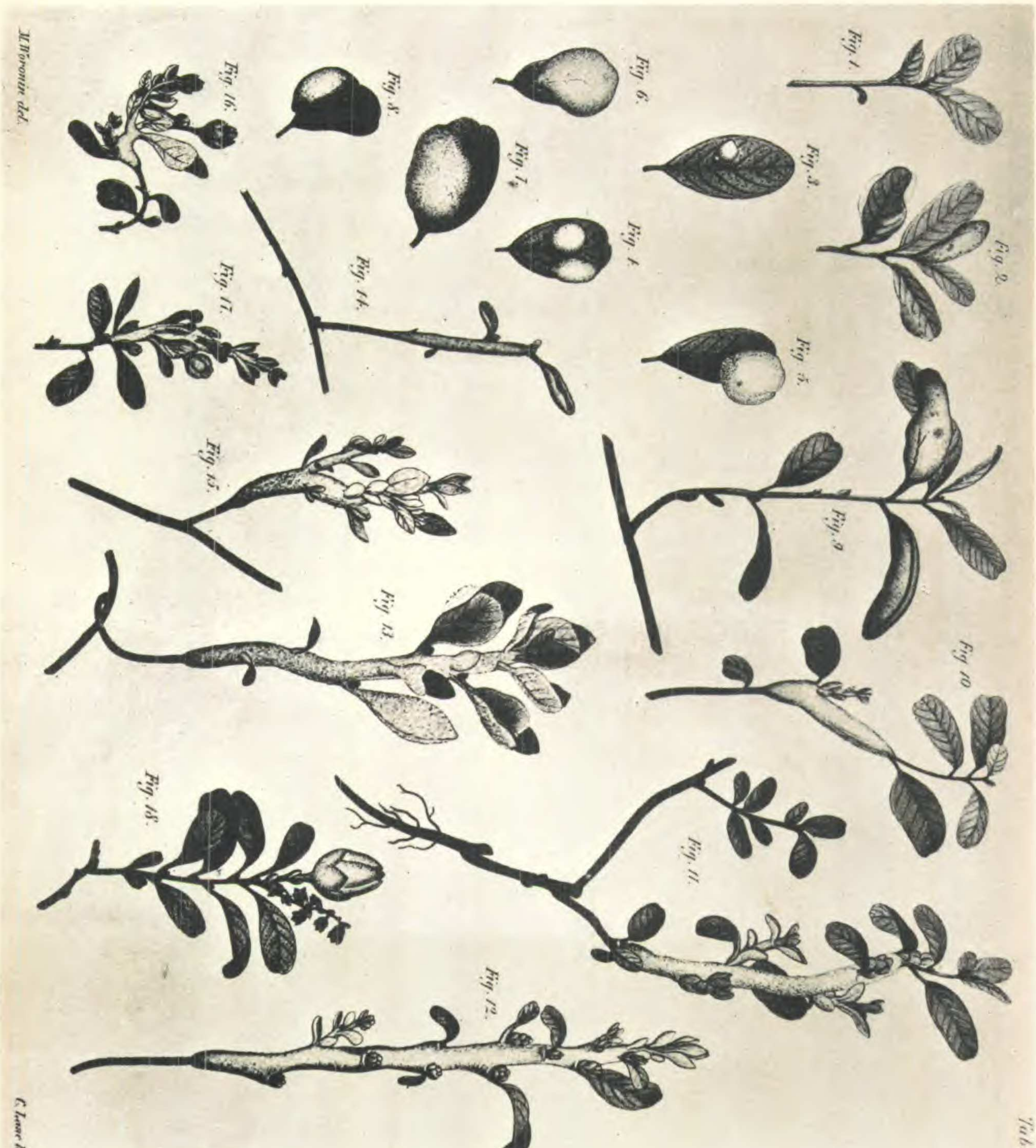
Figs. 2–9. Leaf concavity galls. More or less deformation of the infected region is present here.

Figs. 10–15. Shoot galls of the wax-like or coralloid type. Extended portions of leafy shoots are infected. Figure 11 shows whole branchlets completely hypertrophied.

Figs. 16–17. Flower galls borne on, and a part of, shoot galls.

Fig. 18. Flower gall. Local infection of a single flower, noted as the only such instance observed.

[1] *loc. cit.*



BURT—THELEPHORACEAE OF NORTH AMERICA